Persian J. Acarol., 2021, Vol. 10, No. 3, pp. 351–357.
https://doi.org/10.22073/pja.v10i3.68875
Journal homepage: http://www.biotaxa.org/pja

Correspondence

Eriophyoid mites (Acari: Prostigmata) on common pear (*Pyrus communis* L.): species diversity and varietal attractiveness in the Fomin Botanical Garden (Kyiv, Ukraine)

Lesia M. Bondareva[1*] and Petro Ya. Chumak[2]

1. *Department of Integrated Protection and Plant Quarantine, Faculty of Plant Protection, Biotechnology and Ecology, National University of Life and Environmental Sciences, Kyiv, Ukraine; E-mail: lnubip69@gmail.com*
2. *Department of Plant Protection and Quarantine, Agronomy Faculty, Polissia National University, Zhytomyr, Ukraine; E-mail: Chumakp@i.ua*

[*] Corresponding author

PAPER INFO.: Received: 18 May 2021, Accepted: 10 July 2021, Published: 15 July 2021

Mites of the superfamily Eriophyoidea Nalepa, 1898, are important pests in agriculture and forestry worldwide (Lindquist *et al*. 1996; de Lillo *et al*. 2018). The high economic significance of four-legged mites is associated with their ability to carry phytopathogens and cause the formation of various damages on plants, such as galls, "witch brooms", bud overgrowth, etc. (Sukhareva 1992). That is why many species of four-legged mites, along with spider mites, aphids and other plant pests, are included in the quarantine lists of phytosanitary control services around the world (Chetverikov *et al.* 2015). To date, about 5000 species of eriophyoids have been described, which, according to some researchers, is no more than 20% of their world diversity (Amrine *et al*. 2003). Most of the described species freely live on plants, and only 15–20% of the species live in natural shelters on the host or inside the galls they form. Microscopic size (100–200 microns) and the complexity of long-term maintenance of eriophyoids in plants make them very inconvenient objects for research. This fact significantly complicates the experimental work.

The worldwide published works emphasize the importance of studying this group of mites. The checklists, which show not only new localities of previously studied species, but also new taxa of mites on plants of the genus *Pyrus* L. (Rosaceae), have been created. In the world there are more than 13 species of eriophyoid mites on common pear. Eleven species which belong to two families and five genera, are the most common of four-legged mites on *Pyrus communis* L. The Eriophyidae Nalepa family, 1898, is represented by *Aculus schlechtendali* (Nalepa, 1890), *Aculus fockeui* (Nalepa & Trouessart, 1891), *Epitrimerus pyri* (Nalepa, 1891), *Epitrimerus marginemtorquens* (Nalepa, 1917), *Eriophyes pseudoinsidiosus* (Wilson, 1965), *Eriophyes pyri* (Pagenstecher, 1857), *Phyllocoptes pyri* (Kuang & Hong, 1992), *Aceria chibaensis* (Kadono, 1981), *Phyllocoptes pyrivagrans* (Kadono, 1985), *Eriophyes insidiosus* (Keifer & Wilson, 1955); the Diptilomiopidae family, Keifer, 1944 is represented by one species *Diptacus gigantorhynchus* (Nalepa, 1892). (Kadono *et al.* 1982; Kadono 1985; Lindquist 1996; Amrine *et al*. 2003; Domes 2003; Hellrigl

How to cite: Bondareva, L. & Chumak, P. Ya. (2021) Eriophyoid mites (Acari: Prostigmata) on common pear (*Pyrus communis* L.): species diversity and varietal attractiveness in the Fomin Botanical Garden (Kyiv, Ukraine). *Persian Journal of Acarology*, 10(3): 351–357.

2003; Chen *et al*. 2006; Ripka 2007, 2008; de Lillo *et al*. 2009; Xue *et al*. 2009, 2011; Hong *et al*. 2010; Jočić and Petanović 2012; Denizhan *et al*. 2015; Amrine and de Lillo unpublished database).

The Eriophyoid fauna on *Pyrus communis* L. in Ukraine, despite being an economically significant species, has been poorly studied. Two species of mites have been recorded: *Eriophyes pyri* Pagenstecher, 1857 and *Epitrimerus pyri* Nalepa, 1891 (Vasiliev and Livschitz 1984). Despite the widespread expansion of mites and their growing importance as a component of integrated pest control programs, this group has not been studied in detail in Ukraine's pear plantations. In addition, in modern fruit growing, there is an intensive exchange of plant material between countries; new varieties are being created, therefore, it is important to analyze the species composition of eriophyoid mites, assess the colonization on varieties, as well as collect information for developing the optimal timing of protective measures in pear plantations.

The research was carried out on the territory of the Academician A.V. Fomin Botanical garden, which is located in the center of Kyiv (50° 26′ 35″ N, 30° 30′ 14″ E). Sampling was carried out every five to seven days during the 2018–2020 growing seasons, from foliage, flowers and buds. Samples of the host plant were individually packed in tightly closed bags and on the same day were delivered to the acarological laboratory of the Department of Integrated Plant Protection and Quarantine of NULES. The identification of eriophyid mites was carried out according to the work of Monfreda *et al.* (2009). Mites were extracted from plant material according to the method of Zacharda *et al.* (1988). The mites were mounted on slides following Keifer (1975). Identification was carried out using the relevant keys (Bagdasarjan 1967; Livschitz *et al*. 1981). Observations were also carried out using a 7–10 magnifying glass, on the places inhabited by mites, and on the damage to pears from April to September. All stages of development of eriophyoids and their numbers, as well as the corresponding phenophases of the host plant, were recorded. The number of generations of mites during the season was calculated according to the dynamics of population development, comparing changes in the number of preimaginal and imaginal stages (Livschitz *et al*. 1981).

The differences between summer and winter females were recorded using a microscopic examination method. It is known that summer and winter females differ in morphological characteristics. The summer female develops only in the galls, which affects the structure of her body. It has a fairly thin chitinous cover, narrow half rings, short and thin legs. The winter female has a chitinous cover more durable than the summer female, longer and stronger legs, more pronounced and wider half rings on hysterosome (Hordienko 1974).

The estimated degree of colonization of *Pyrus communis* L. varieties by *Eriophyes pyri* were produced under stationary conditions in the second decade of August. All varieties were divided into five groups, depending on the degree of colonization (score) of leaves with mites: I - very low (1 point; < 5% are covered with galls), II - low (2–3 points; 5–25% are covered with galls); III - medium (4–5 points; 26–50% are covered with galls), IV - high (6–7 points; 51–85% are covered with galls), V - very high (8–9 points; > 85% are covered with galls).

In the course of the monitoring, we identified three species of four-legged mites in the pear plantations of the botanical garden. They were dominated by pear gall (*Eriophyes pyri* Pgst.) and rusty pear (*Epitrimerus pyri* Nal.). For the first time, individuals of *Epitrimerus marginemtorguens* Nal., were found on pear leaves. This type of mite appeared mainly in the second half of the growing season and did not cause much harm to the fodder plant. According to Ripka (2007), in Hungary conditions, *Epitrimerus marginemtorguens* usually lives on apple trees. His observations are consistent with the data for Ukraine (Hordienko 1974). But in Iran, this species is also spread on pears (Xue *et al*. 2009). Vasiliev and Livschitz (1984) note the feeding of this species on *P. communis* in the area of the city of Yerevan (40° 11′ N, 44° 31′ E), which is located significantly south of Kyiv. We have not seen other reports on the spread of *E. marginemtorguens* in the territory of Ukraine and neighboring countries in the literature. The presumably intensive exchange of planting material and the climate warming contribute to the appearance of previously absent species

of mites in regions with a temperate climate, where they were not previously recorded (Bondareva and Chumak 2020).

Eriophyes pyri Pgst. is a widespread and dangerous pest of pears in all localities of cultivating this plant species in Ukraine. In the course of studying the phenology of the species, we have noted a certain pattern of leaf damage. In the spring, a rosette with 5–7 leaves is formed on the branches of the previous year. As soon as the leaves unfold, the mite gets settled and over time the first galls are formed here (Fig. 1). During this period, damage to the young pedicel also occurs. Females lay eggs in galls, where the first generation of the pest develops. In the study region, this process is observed at the beginning of May. The formation of shoots of the current year occurs with some delay. On them, as a rule, the lower or first leaves remain intact. The mite and its larvae are found in the galls. The migration of the first generation of *Eriophyes pyri* from galls can be determined by the identification of newly formed galls on young leaves of the growing shoots. This corresponds in time to the formation of 7–9 leaves on the shoot. Leaves formed on the shoot up to the 7th ordinal leaf do not have galls. This indicates that at the time of the emergence of the first generation mites from the maternal galls, the leaves were physiologically unsuitable ("old") for feeding the mite and for the formation of galls. The process of colonizing newly formed leaves on the shoot with mites lasts until the formation of the middle section of a young shoot, up to about 7–9 ordinal leaves. Often, having populated these leaves, the mite stops there. That is, the transition of mites of the first generation to new leaves occurs with a delay, and it is not long in time. As a rule, on a young branch, the lower and upper leaves remain intact (Fig. 2).

In the first decade of June, the development of the first generation ends. With the growth of the shoot, and the formation of young leaves, their gradual colonization by the second generation mites begins. In late June – early July, mites of the second generation form galls on the leaves of the upper part of the pear shoot. The development of the third generation of *Eriophyes pyri* is observed in late July – early August on the leaves of the shoot tip. The process of migration of winter females to the buds for wintering lasts until the end of August. The described course of pest migration on pear varieties of different ripeness of fruits and under different coenotic circumstances may vary, though insignificantly in terms of time. In the temperate climate of Kyiv, *Eriophyes pyri* develops three generations.

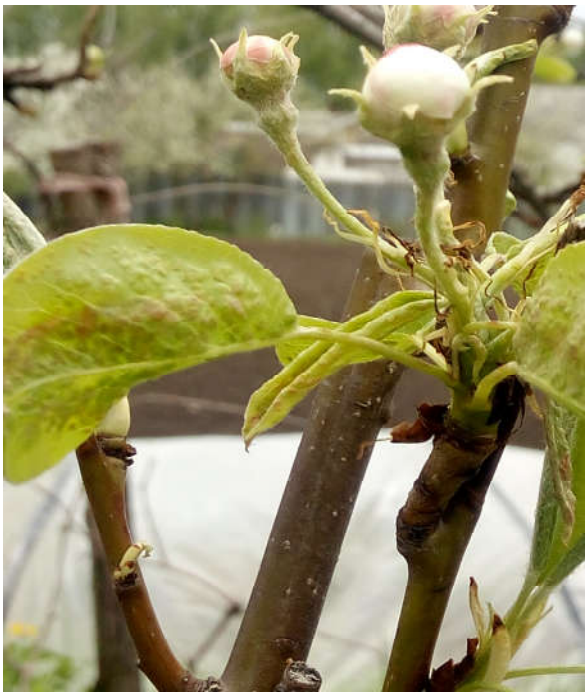

Figure 1. Young pear leaves damaged by the first generation of *Eriophyes pyri* (Academician Fomin Botanical Garden, May 2021).

Figure 2. Pear leaves damaged by the second and third generations of *Eriophyes pyri* (Academician Fomin Botanical Garden, 2020).

The treatment of pears with pesticides in the system of pest control is often scheduled in the spring, but we did not observe a high efficiency against *Eriophyes pyri*. Damage to foliage by the second and third generations of the pest is common, specifically in organic gardening.

Such a sequence of colonizing the leaves by *Eriophyes pyri* on a growing pear shoot is of practical importance for carrying out protective measures within the optimal period of time. The period of formation of 7–9 ordinal leaves on the growing shoot is the key moment when the first generation of mites leaves the old galls and colonizes the newly formed leaves. During this period, the phytophagy moves from a hidden to an open way of life and is available to methods and means used in plant protection. Acaricides are highly effective and preparations of biological origin can be used, for example, Aversectin C 5% EC. But this period is short-timed and requires careful monitoring. For this purpose, sticky tape such as scotch tape can be used. A similar moment is also observed during the migration of the second generation to the apical leaves and the third generation to the buds for wintering, but this process is greatly extended over time and is not so suitable for the use of acaricides. A similar moment is also observed during the migration of the second generation to the apical leaves and the third generation – to the buds for wintering, but this process is greatly extended over time and is not so suitable for applying the acaricides.

We have also found individuals of *Epitrimerus pyri* Nal., on pear leaves. This species is less harmful in the pear plantations of the botanical garden. Straw-yellow winter females hibernate, singly or in groups in bark crevices. With the beginning of the growing season, they migrate to the blossoming buds and, having settled on the underside of the leaves, mainly along the median vein, they begin to feed and lay eggs. Summer females appear in mid – late May. In June–July, as the leaves become coarser, an increasing number of winter females emerge, which migrate to wintering places. The maximum density of *Epitrimerus pyri* (200 individuals/leaf) was noted at the end of August. In the process of the pest feeding, the leaves are deformed, their edges are bent upwards, and from below they acquire a bronze tint. Damaged flowers and young ovaries fall off prematurely. Three to four generations develop a year.

In modern conditions, the market requirements for fruit quality have become much higher, so it is important to assess the status of pest mites and the damage done to pear production. Knowledge of the resistance of crop varieties to phytophagous mites can reduce the pesticide load in fruit plantations and the cost of carrying out protective measures. Due to the fact that phytophagous mites very quickly acquire resistance to acaricides applied in production, it is particularly important to evaluate pear varieties for susceptibility to them.

Table 1. Damage to pear varieties by *Eriophyes pyri* in the conditions of the Academician Fomin Botanical Garden (average for 2018–2020)

Group	Points and degree of plant damage	Pear variety
I	very low	Williams Rouge Delbara
	1 point; < 5% are covered with galls	Williams summer
		Ilyinka
		Clapp's Favorite
II	low	Bergamot Mlievsky
	2–3 points; 5–25% are covered	Beurré Giffard
	with galls	Beurré Clairgeau
		Beurré d'Ligueil
		Beurré Sterkmans
		General Kirponos
		General Totleben
		Dekanka Meroda
		Doctor Lucius
		Sen-Zhermen
		Josefina
		Limonka
		Originalnaya
		Polesskaya
		Triomphe de Joduan
III	medium	Beurré Ardanpon
	4–5 points; 26–50% are covered	Beurré 'Bosc'
	with galls	Beurré Hardy
		Beurré Diel
		Beurré Napoleon
		Grand Champion
		Duchesse
		Winter Mlievskaya
		Conférence
		Forest beauty
		Aleksandrovka
		Parisienne
IV	high	Yellow Mlievskaya
	6–7 points; 51–85% are covered with galls	Royal Winter
		Tayushchaya
V	very high	Beurré Kyivskaya
	8–9 points; > 85% are covered	Zolotistaya
	with galls	Dekanka winter
		Crymskaya winter
		Willow pear *Pyrus salicifolia* Pall

Comparative evaluation of collection plantations of pears of the Academician A.V. Fomin Botanical Garden, made it possible to identify the most tolerant and damaged varieties to eriophyid mites. It should be noted that *Eriophyes pyri* was present in all pear varieties studied. It was noted that four summer varieties – “Williams Rouge Delbara”, “Williams Summer”, “Ilyinka” and

“Clapp's Favorite” were damaged very slightly (I group), slightly (II group) 15 varieties of different maturity dates were infested. Twelve varieties of common pear were moderately damaged (group III). Severe damage (group IV) was recorded on three varieties: "Mlievskaya Yellow", "Royal Winter" and "Tayushchaya". But mainly the varieties of the common pear (*P. communus* L.) of the winter maturity have appeared the most damaged (group V): "Beurré Kyivskaya", "Zolotistaya", "Dekanka winter”, “Crymskaya winter”, as well as Willow pear (*Pyrus salicifolia* Pall) (Table 1).

Here, we have determined the species composition of Eriophyoidea mites on plants of the *P. communis* L. genus on the territory of the Academician A.V. Fomin Botanical Garden. It has been found that *Eriophyes pyri* Pgst. and *Epitrimerus pyri* Nal. dominate. For the first time, individuals of *Epitrimerus marginemtorguens* Nal., have been found on pear leaves. The sequence of colonization of *Eriophyes pyri* leaves on a growing shoot of a pear has been determined, which is of practical importance for carrying out protective measures as soon as it is practicable. The level of infestation of *P. communis* varieties by phytophagous mites has been established. Twenty-seven varieties had low and medium damage. Seven varieties of *P. communus* and *P. salicifolia* have been classified as the most damaged by *Eriophyes pyri*. Along with this, four summer varieties have been very slightly damaged. This data should be taken into account for monitoring pest mites and planning population control measures.

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